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National Survey of Family Growth, Cycle III Sample Design, Weighting, and Variance Estimation

This report describes the procedures used to select the sample, estimate population parameters, and estimate sampling variances for Cycle III of the National Survey of Family Growth.

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Preface

This report presents a detailed description of the sample design, estimation procedures, and variance estimation method used in Cycle III of the National Survey of Family Growth. The survey was designed and conducted by Westat, Inc., of Rockville, Maryland, under a contractual arrangement with the National Center for Health Statistics (NCHS). The sampling plan was developed under the supervision of Joseph Waksberg of Westat, Inc., in consultation with E. Earl Bryant and William F. Pratt of NCHS.

Some of the report is based on survey specification documents and the final report prepared by Westat, Inc., and on internal NCHS memoranda. Parts of the report are also based on previous reports prepared by Dwight K. French, on the Cycle I survey, and William R. Grady, on the Cycle II survey.

Mr. Dwight K. French, of the National Institute on Aging, and Mr. Joseph Waksberg, of Westat, Inc., served as peer reviewers of this report, and made many useful comments and suggestions.

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Symbols used in tables

- - -	Data not available
. . .	Category not applicable
-	Quantity zero
0.0	Quantity more than zero but less than 0.05
Z	Quantity more than zero but less than 500 where numbers are rounded to thousands
*	Figure does not meet standard of reliability or precision
#	Figure suppressed to comply with confidentiality requirements

National Survey of Family Growth, Cycle III: Sample Design, Weighting, and Variance Estimation

by Christine A. Bachrach, Ph.D., Marjorie C. Horn, M.A., and William D. Mosher, Ph.D., Division of Vital Statistics and Iris Shimizu, Ph.D., Office of Research and Methodology

Introduction

The National Survey of Family Growth was established in 1971 in the National Center for Health Statistics (NCHS), Division of Vital Statistics. The purpose of the survey is to provide current information on childbearing, contraception, and related aspects of maternal and child health. It is a periodic survey, conducted every few years. The first cycle was conducted in 1973, the second in 1976, and the third in 1982.

The target population of Cycles I and II of the National Survey of Family Growth (NSFG) was the civilian household population of women 15–44 years of age in the conterminous United States, who were currently married, previously married, or never-married mothers with offspring living in the household at the time of interview.

The target population for the Cycle III survey was expanded to include women of all marital statuses and women living in group quarters. Thus the Cycle III survey represents the civilian noninstitutionalized population of women 15–44 years of age. Data for all three cycles were collected from probability samples by means of personal interviews lasting an average of 1 hour. The interviews provided information on fertility trends and differentials, contraception, breast feeding, family planning services, and aspects of maternal and child health closely related to family planning.

The sample design and data collection for Cycle I were contracted to the National Opinion Research Corporation of the University of Chicago. The sample design and data collection for Cycles II and III were contracted to Westat, Inc. of Rockville, Md. Descriptions of the Cycle I and Cycle II surveys can be found in other reports.[1,2] Cycle III is based on interviews with 7,969 women (about 5 percent more than the 7,600 expected to be in the sample). The interviews were conducted between August of 1982 and February of 1983 and centered on October 1982. This report describes the sample design used to select the women, the techniques used to estimate population parameters, and the procedures used to estimate sampling variances.

Design Specifications

Efficient sample design must take into account the primary survey objectives, the amount of funds available, logistical problems, time limitations, estimates of population characteristics and distribution, and operating costs. These requirements dictated a stratified multistage probability sample design for Cycle III, based on the following set of specifications:

- The target population was defined to be the noninstitutionalized population of women 15–44 years of age who were living in households or group quarters in the conterminous United States.
- The sample was to consist of approximately 7,600 women, selected from an initial probability sample of households. It was to include about 3,100 black women and 4,500 women of other races; by age, the sample would include about 2,000 women 15–19 years of age, and 5,600 women 20–44 years of age. Trained field staff were to conduct a screening interview with a responsible member of each sample household to determine if there were any eligible women. No more than one randomly selected eligible woman per household was to be interviewed.
- Data were to be collected from the sample women by means of personal interviews lasting an average of 1 hour. No proxy respondents were to be accepted.
- All interviewers were to be female.
- The interviewer was to collect information on fertility, contraceptive use, sources and types of family planning services, and related aspects of maternal and child health using a highly structured, printed questionnaire.
- The fieldwork was to be completed in approximately 4½ months.
- The target interview completion rate for the total sample and both major subsamples by race was to be 90 percent of the expected number of women from all sample households (that is, screener and interview nonresponse combined should ideally be no more than 10 percent).
- The contractor, in cooperation with the National Center for Health Statistics (NCHS), was to design and implement procedures to measure and control the quality of data collection and data preparation.

Sample Design

Summary

The sample design for Cycle III of the National Survey of Family Growth (NSFG) was a 5-stage area probability design that incorporated oversamples of black and teenage women and a supplementary sample of women living in college dormitories and sororities. This section summarizes the design and is followed by sections discussing each stage in detail. Figures 1 and 2 illustrate the stages of sample selection.

The counties and independent cities that form the total land area of the conterminous United States were combined to form a frame of primary sampling units (PSU's). During the first stage of the sampling process, which involved extensive stratification, 79 PSU's were chosen from this frame. Census block groups (BG's) and enumeration districts (ED's) were then identified for each of the selected PSU's; during the second stage, these BG's and ED's were stratified into two groups according to the percent of their population that was black, and a systematic sample was drawn from each. The rate at which BG's and ED's were sampled varied from one second-stage stratum to the next. These differential sampling rates were the first step in producing the desired racial composition of the final sample of women. In the third stage, area segments (groups of houses or apartments) within sample BG's and ED's were identified, and one segment was selected randomly from each district.

The fourth stage was to select households within sample segments. In segments from the "black" stratum (that is, enumeration districts with a 10-percent or greater black population), black households were selected at a higher rate than other households. These different rates of selection were obtained through a subsampling process (to be described later in this report) so that the desired proportions of black and other women would be included in the final sample. In the fifth stage of sampling, women were selected from all eligible households. At each sample household, an interviewer attempted to complete a household screener and identify women eligible for interview. No more than one woman was selected from any household. In most households containing one eligible woman, that woman was selected for interview; however, in some households with one eligible woman, no respondent was selected for interview. The percent of households in which no eligible woman was interviewed depended on the stratum, the number of eligible women in the household, and the age and marital status of each.

Women living in households were selected in the manner described above, but women living in college dormitories or sororities were selected from a sample of colleges with undergraduate female enrollment located within the 79 PSU's selected in the first stage of the sampling process. Within the selected colleges, women were systematically sampled from a list of all women living in college dormitories or sororities. The detailed description of the sample design follows.

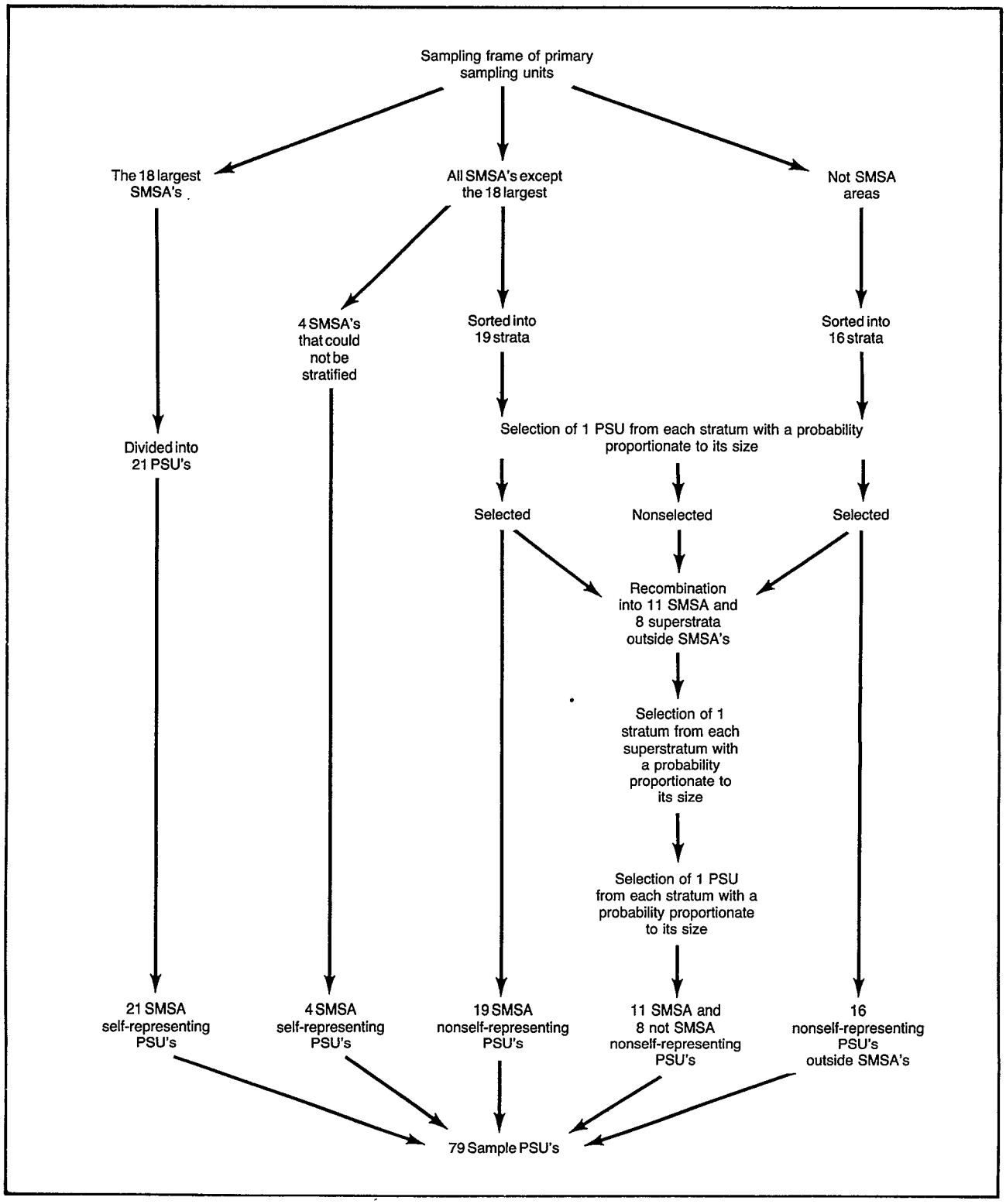


Figure 1. First-stage selection of primary sampling units

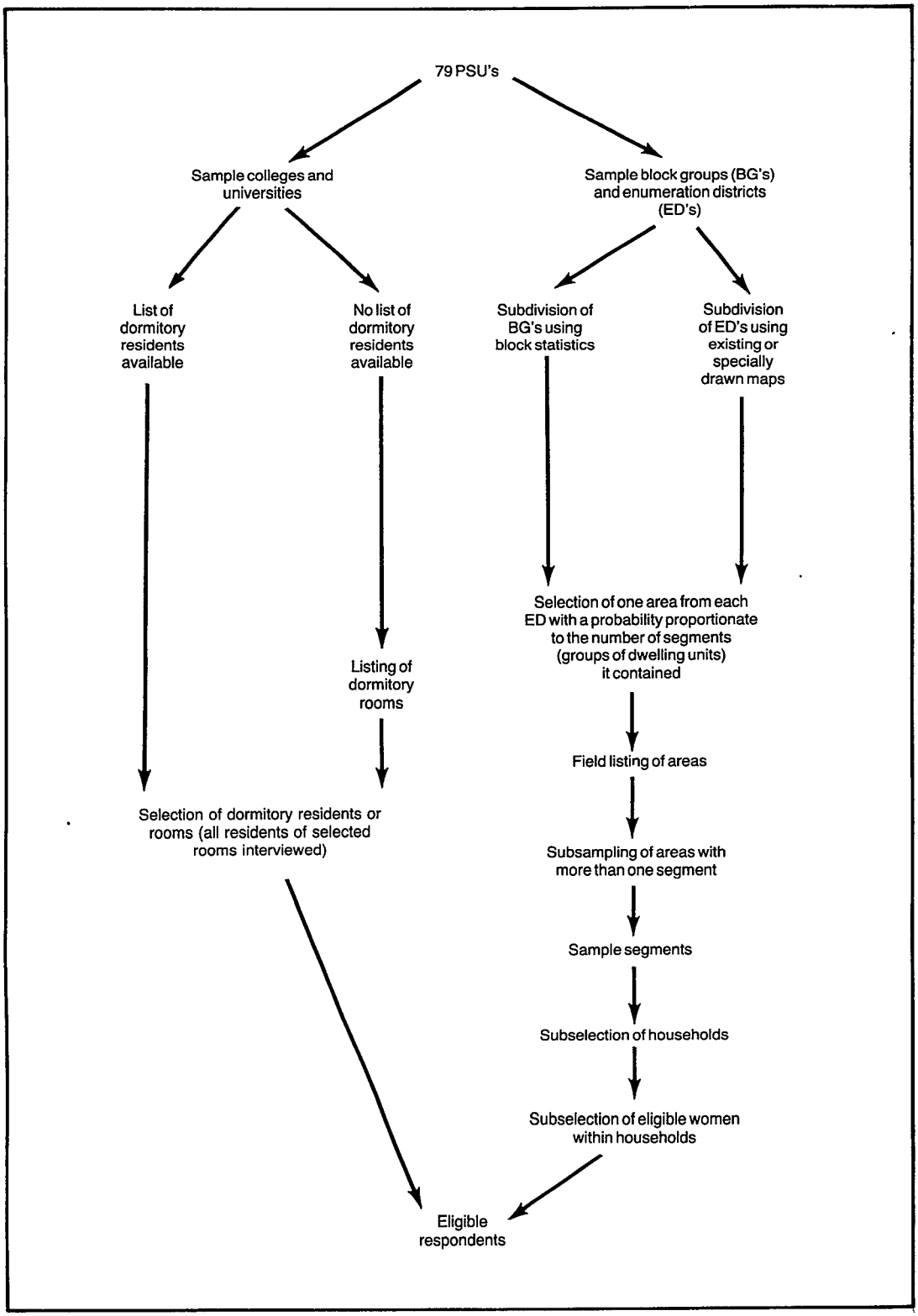


Figure 2. The second through fifth stages of sample selection

First-stage selection of primary sampling units

Sampling frame

The counties and independent cities of the conterminous United States were grouped into about 1,900 primary sampling units (PSU's) by the U.S. Bureau of the Census for its Current Population Survey. These census PSU's were used by Westat, Inc., with minor modifications, as the sampling frame for the National Survey of Family Growth. Each PSU consisted of an individual county or a grouping of contiguous counties. Where standard metropolitan statistical areas (SMSA's) were defined, the counties composing each SMSA were used as a primary sampling unit. Seventy-nine PSU's were selected in the first stage of the sampling process.

The sample contains 25 self-representing (included with certainty) primary sampling units composed of 18 separate SMSA's. These include the 14 largest SMSA's, with 1970 populations of more than 1,850,000, and 4 slightly smaller ones that were made self-representing because they could not easily be placed in strata with other primary sampling units. Four of the largest SMSA's, which contained several counties each, were subdivided into smaller primary sampling units with an average population of about 2,500,000.

Selection of nonself-representing PSU's

Before selecting the remaining 54 PSU's, all nonself-representing PSU's (probability of selection less than unity) were grouped into 35 strata of approximately equal size. Nineteen strata contained SMSA's, and 16 contained areas not in SMSA's.

The more than 200 nonself-representing SMSA's were sorted into 19 strata of about 4,000,000 persons each. In defining the appropriate stratum, four characteristics were considered. In order of priority, these characteristics were the following:

1. Region of the country.
2. Percent change in population between 1960 and 1970.
3. Percent of the population employed in manufacturing.
4. A Socioeconomic Index (developed by Westat, Inc.) that was based on the percent of the population that was white, the percent of households that either lacked plumbing or was overcrowded, and the dependency ratio. (The dependency ratio is the sum of the population aged 0-17 and 65 and over, divided by the population aged 18-64.)

The nearly 1,700 remaining PSU's not in SMSA's were then sorted into an additional 16 strata. The criteria in order of priority for this stratification were as follows:

1. Region of the country.
2. Percent of the population living in urban areas.
3. Percent change in population between 1960 and 1970.
4. The Westat Socioeconomic Index.

This stratification insured the proportionate representation of women by region and socioeconomic status, thus reducing sampling error.

Following the stratification process, 54 nonself-representing PSU's were selected in two stages. In the first stage, 1 PSU was selected from each of the 35 strata with a probability proportionate to size. The second-stage selection of the remaining 19 PSU's was then accomplished in 3 steps. First the 35 strata were combined into 19 superstrata that were, as far as possible, homogeneous with respect to region, metropolitan composition (SMSA or not SMSA), rate of population change between 1960 and 1970, and the percent of the population that was black.

Four of the resultant superstrata contained a single stratum each, 14 contained 2 strata, 1 contained 3 strata. The second step was to select, with a probability proportionate to size, a single stratum within each superstratum. The final step was to select 1 PSU from each of the 19 strata, also with a probability proportionate to size. Because the second-stage selection of 19 PSU's was done independently of the first-stage selection of 35 PSU's (that is, sampling was done with replacement), it was possible for PSU's to be selected twice; this occurred in 1 PSU. A diagram of how the PSU's were selected is shown in figure 1.

Second-stage selection of enumeration districts

Sampling rates

As shown in table A, different sampling rates for black women and for those of other races were required because the final sample of women for the National Survey of Family Growth was intended to consist of approximately 3,100 black women and 4,500 women of white and other races. The sampling fraction needed to produce the required number of black women was much higher than the corresponding fraction for white and other women. The first step in producing these disparate rates occurred in the second stage of the

Table A. Estimated number of eligible women, expected sample size, and sampling fractions, by race, age, and marital status: 1982 National Survey of Family Growth

Race, age, and marital status	*Estimated number of eligible women*[1]	*Expected sample size*	*Approximate sampling fraction*
All races	54,099,000	7,605	1 in 7,110
15–19 years of age	9,521,000	2,015	1 in 4,730
20–44 years of age:			
Never married[2]	10,325,000	1,265	1 in 8,160
Ever married	34,253,000	4,325	1 in 7,920
Black	6,985,000	3,115	1 in 2,240
15–19 years of age	1,416,000	665	1 in 2,130
20–44 years of age:			
Never married[2]	2,168,000	715	1 in 3,030
Ever married	3,401,000	1,735	1 in 1,960
White and other races	47,114,000	4,490	1 in 10,490
15–19 years of age	8,105,000	1,350	1 in 6,000
20–44 years of age:			
Never married[2]	8,157,000	550	1 in 14,830
Ever married	30,852,000	2,590	1 in 11,910

[1]These estimates are ratio-adjusted to population counts interpolated to October 1982, from the March 1982 and March 1983 Current Population Surveys.
[2]Never married means never formally married, and ever married means ever formally (legally) married.

sampling process: The selection of 1980 census BG's and ED's within sample primary sampling units. This was accomplished by stratifying BG's and ED's by the percent of the population that was black, and by using a higher rate of selection in strata with a 10-percent or greater black population.

Stratification of BG's and ED's

Before the BG's and ED's were stratified, a certain amount of recombination was necessary to assure that each ED and block group contained at least as many housing units as the desired segment size for the stratum in which the ED was located. Thus, some of the smallest ED's and block groups were combined into single larger ones. For ease of discussion, block groups, ED's, and recombined block groups and ED's are all referred to as ED's.

The stratification of ED's was accomplished on the basis of information included in the 1980 Census of Population and Housing.[3] These data were used to determine the proportion of the population of each ED that was black, and thus to which stratum the ED should be assigned. The strata were defined as follows:

- Stratum 1: ED's with a black population of 60.0 percent or more.
- Stratum 2: ED's with a black population of 30.0 to 59.999 percent.
- Stratum 3: ED's with a black population of 10.0 to 29.999 percent.
- Stratum 4: ED's with a black population of 0.0 to 9.999 percent.

Determination of size

After this initial stratification by race, each ED was assigned a measure of size, which was the number of area segments (groups of year-round housing units) that it would contain if selected. The size of each area segment, in turn, was a function of the ED stratum. Housing data for segments were not available from the 1980 Census when the sample was selected, so the number of housing units was estimated by dividing the ED's population by conversion factors based on average household size (from the Current Population Survey). The ED's measure of size was then calculated by dividing the estimated number of housing units by the average number of housing units per segment. The averages used were 28 in strata 1 and 4, 56 in stratum 2, and 84 in stratum 3. The measure of size for ED's in strata 1 and 4, for example, was thus the estimated number of year-round housing units they contained divided by 28.

Sequencing of enumeration districts

Folowing the assignment of the measure of size described above, all enumeration districts were sorted by: (1) PSU number, (2) stratum code, (3) census tract number in tracted areas and minor civil division (MCD) in nontracted areas, and (4) ED or block group number within tract or MCD. The sequencing operation, combined with the systematic sampling of ED's that was carried over from 1 primary sampling unit to the next and from 1 stratum to the next, produced an effective geographic stratification of ED's. This stratification was intended to achieve a reduction in sample variance by ensuring a geographically representative sample.

Selection of enumeration districts

Before the sampling operation, the measure of size (number of segments) for each ED was inflated by the inverse of the probability of selection for the primary sampling unit in which it was located. This weighting has two effects: Households from all PSU's have exactly the same overall probability of being included in the final sample, and a representative sample can be achieved while using the same sampling fraction across all PSU's.

A systematic sample of ED's was drawn using one random start and a sampling interval of 866 segments in strata 1 through 3, and 6,280 segments in stratum 4. Thus, the segment corresponding to the random start and every 866th or 6,280th segment thereafter was identified, and the ED's in which they fell were selected. Only one random start was needed. The systematic sampling was carried over from 1 stratum to the next within primary sampling units and from the last ED selected in 1 PSU to the first ED in the next.

Third-stage selection of segments

Initial subdivision of segments

Each enumeration district or block was divided into the number of segments that had been determined during the second stage of the sampling process. In BG's, 1980 census block statistics and block maps were used in the first step of this subdivision. Each block (or occasionally, group of contiguous blocks) was then assigned one or more segments based on the number of dwelling units (DU's) it contained and on the segment size (for the stratum).

When block statistics were not available, census county and place maps were used. If the physical features shown contained enough information, the maps were used to divide the ED into segments. Where these maps were inadequate, field interviewers were sent to the sites to prepare sketch maps for an initial subdivision. However, the physical features of these rural areas did not always allow the ED's to be divided into segments of the desired size. Thus, as with block areas, these initial subdivisions sometimes included more than 1 segment.

Selection, field listing, and subsampling of area segments

Regardless of the method used to divide each enumeration district into land areas, one area was randomly selected from each district with a probability proportionate to the number of segments it contained. If the area contained only 1 segment (had a measure of size of 1) it became a sample segment. However, some areas had a measure of size that was greater than 1; that is, they included more DU's than was appropriate for a single segment. In these cases dwelling units were subsampled to produce sample segments of the proper size.

For exceptionally large segments, however, an additional operation was introduced before listing the addresses. The maps for these segments were used to prepare sketch maps containing further subdivisions of the areas. The resultant subsegments were then assigned a measure of size based on approximate DU counts, and the maps were returned to Westat, Inc., for the selection of 1 subsegment for listing and inclusion in the final sample.

The listing operation was designed to produce detailed address information for each dwelling unit in all segments, to be used in subsampling segments with measures of size greater than 1 and also for assignment to interviewers in the screening and interviewing stages of the field work. For each assigned segment, the lister received a "segment folder" that included a census map, two sketch maps, and address listing sheets. She then went to the segment, verified the segment boundaries, corrected the maps when necessary, and listed the address of each dwelling unit in the segment (or recorded a detailed description of the unit if the house or apartment number was not evident). The listing was verified through checks for missed dwelling units during the interview stage of the survey.

If the segment had more addresses than were required for the sample, a systematic sampling procedure was used. For example, if a segment had twice the number of DU's dictated by the stratum from which it was drawn, then every second DU on the address listing sheets was designated for interview. The disposition of the dwelling units in the sample is shown in table B.

Table B. Unweighted and weighted number of dwelling units (DU's), by final disposition

Final disposition	*Unweighted number of sampled DU's*	*Weighted number of DU's*[1]
All DU's		
Total	34,630	34,641
Vacant or not a DU	3,559	3,614
Occupied DU	31,071	31,027
Disposition of occupied DU's		
Completed screener interview	28,817	29,511
Eligible and selected for extended interview	9,804	9,964
Completed extended interview	7,969	8,321

[1]DU's included in the nonresponse subsample are weighted double (see text for explanation).

Missed dwelling units

During the interview phase of the survey, interviewers were required to check for dwelling units not discovered during the listing operation. These dwelling units may have been missed as the result of the lister having overlooked either entire structures or individual DU's within listed structures, or because they were constructed after the listing had been completed. The procedures for locating and including missed DU's in the sample were designed to give them the same probability of selection as other DU's from segments in the same stratum. The procedure was as follows:

- At each sample address that had been listed as a single-family home, the interviewer checked to ensure that all DU's located in that structure were listed. The check included questioning respondents about possible missed dwelling units and looking at mailboxes or doors that might give indications of a unit not listed. Any additional dwelling units located were also included in the sample.
- In multiunit structures, the interviewer looked for missed dwelling units within the structure *only* if the first-listed unit in the building was included in the sample. Any additional dwelling units located in this manner were included in the sample.
- In segments, missed structures were searched for *only* if the first-listed structure in that segment was included in the sample. When missed structure checks were initiated, the procedure included canvassing the segment by foot or by car, using the segment map and listing sheets to look for additional structures, and asking respondents about possible missed structures in the area. All dwelling units located in missed structures were included in the sample.

Having the first-listed unit determine whether a missed DU or missed structure check was made ensured that the self-weighting feature of the sample was retained. The check was made for all segments and structures in which all the DU's were included in the sample, for half of the segments and structures in which the subsampling rate had been 1 in 2, for one-third of the segments and structures in which the subsampling rate had been 1 in 3, and so on. The only deviation from this self-weighting principle occurred when 5 or more missed DU's were located in a single missed structure or at a DU listed as a single unit. In these cases the interviewer contacted the sampling department

at Westat, Inc., which then selected 4 of the DU's for inclusion in the sample. Weights for these cases were appropriately adjusted. The missed dwelling unit check increased the total number of DU's in the sample by 2.6 percent.

Fourth-stage selection of households

The fourth stage of sample selection (selection of households) was carried out during the household screening. The household screening consisted of a short interview with a responsible member of each designated household in a segment. The purposes of screening were to determine the number of women in the household who were eligible for the extended interview, and to classify them by age and marital status.

Subsampling for age, race, and marital status

The sample design required that black women and women 15–19 years of age be sampled at higher rates than other women and that specified numbers of ever-married and never-married women be included in the sample (table A). These goals were accomplished by a combination of subsampling households and subsampling women within households.

Subsampling of households was based on stratum, the race of the screener respondent, and the age and marital status of the household members. Households were divided into two groups: (1) black households in all strata, and white and other households in stratum 4 (less than 10 percent black), and (2) "white and other" households in strata 1–3. Households in the second group were divided into three subgroups of unequal size (2a, 2b, 2c). In group 2a, households were retained in the sample only if they contained a woman 15–19 years of age. In group 2b, households were initially included only if they contained an ever-married woman 20–44 years of age; and in group 2c, households were initially included only if they contained a never-married woman 20–44 years of age. Group 2a consisted of 60 percent of all white and other households in strata 1–3, and groups 2b and 2c each consisted of 20 percent of all such households.

In response to a shortfall in the number of teenagers in the sample, households falling into groups 2b and 2c were later included in the sample if they contained a woman 15–19 years of age, and no other household member had been selected for interview.

Fifth-stage selection of sample persons

Women living in the same household tend to have similar characteristics—such as education, income, family background, and religion. If more than one woman from each household had been included in the sample, their background and behavior would have been correlated. To avoid this unwanted correlation of information from eligible women within the same dwelling unit, no more than one sample woman from any sample household was interviewed. In addition, in order to obtain the desired sample composition by age, race, and marital status, different rates of selection of women of each characteristic were established within eligible households.

Eligible women within a household were selected by using computer-generated sampling tables attached to each questionnaire. After all women in the household were listed on the screener and the race of the household was determined, the interviewer consulted the sampling table to determine which woman, if any, was selected to receive the extended interview.

The sampling rates used within screened eligible households are shown in figure 3 but can be briefly described as follows. In households with only one eligible woman, that woman was always chosen if she was 15–19 years of age or if she belonged to a black household in stratum 4. In other eligible households the probability of selection was less than 1.0. In households with more than one eligible woman, one woman was always chosen, but 15–19-year-old women were selected at twice the rate of other women, except for white and other households in strata 1–3.

Figure 3. Subsampling rates within screened eligible households

Age and marital status of women in eligible households[1]	*Black households*		*White and other households*	
	Strata 1–3	*Stratum 4*	*Strata 1–3*	*Stratum 4*
Households with 1 eligible woman				
A. 15–19 years of age	1.00	1.00	1.00	1.00
20–44 years of age:				
B. Ever married	.99	1.00	.65	.51
C. Never married	.80	1.00	.85	.45
Households with multiple eligible women[2]				
A. 15–19 years of age	2/(2A + B + C)	2/(2A + B + C)	1/A	2/(2A + B + C)
20–44 years of age:				
B. Ever married	1/(2A + B + C)	1/(2A + B + C)	1/B	1/(2A + B + C)
C. Never married	1/(2A + B + C)	1/(2A + B + C)	1/C	1/(2A + B + C)

[1] All screened households are eligible except white households in strata 1–3 For this group, 60 percent were designated as eligible for teenagers 15–19 years of age, and 20 percent designated for each of the other two groups; however, households with teenagers in the other two groups were also eligible if no one 20–44 years of age was selected

[2] In the subsampling rates shown, A is the number of teenagers 15–19 years of age in the sampled households and B and C are the numbers of women 20–44 years of age ever married and never married, respectively.

The sample of women living in college dormitories and sororities

A multistage probability sample was used to select the college dormitory sample (figure 2). The PSU's that compose the first stage of the sample are the same 79 PSU's selected for the area probability sample. The second stage of the sampling process resulted in the selection of a sample of 4-year colleges and universities. Schools were selected with a probability proportionate to the number of undergraduate women enrolled, using data for 1979–80, published by the National Center for Education Statistics. Undergraduate female enrollment was the best indicator of the female college dormitory population that was available for all colleges in the PSU's. Before selection, the measure of size for each college was inflated by the inverse of the probability of selection for the PSU in which the college was located. This procedure gave all women living in college dormitories and universities an equal overall probability of selection.

Eighteen schools were selected as the main sample, and 18 additional schools were selected as a reserve sample, to be used as substitutes for main sample schools that refused to cooperate. The reserve sample schools were selected by the same procedures as the main sample schools. Four of the 18 main sample schools refused to cooperate and were replaced by reserve sample schools. Within selected schools one of two alternative methods was used to sample women (figure 2). In schools that made available a complete list of women living in dormitories and sororities, women were subsampled directly from that list. When these lists were not available, all rooms in the school dormitories and sororities were listed and subsampled, and women residing in all the sampled rooms were interviewed. Initially the rate of selection for women in the dormitory sample was to be the same as for never-married women 20–44 years of age living in stratum 4 area segments; however, this rate was later doubled in order to supplement the number of women aged 15–19 obtained in the sample.

The use of a supplementary sample of college dormitories in addition to the regular household sample introduced the possibility that college students could fall into the NSFG sample at two points—at their dormitories and at their parents' homes. To avoid such duplication, in the household screener interview the question was asked, "Do any of the people in this household live anywhere else most of the time—for instance, college students living away from home?" Individuals identified with this probe were not considered to be living in the household.

Nonresponse followup

Subsampling of nonresponse cases

After all efforts to complete an interview (either a screener or an extended interview) were exhausted by local interviewers, nonresponse cases that appeared to be convertible were assigned to an elite corps of traveling interviewers and assistant supervisors. Before the followup interview effort, a 50-percent subsample of these cases was selected using systematic cluster sampling procedures. This subsampling, designed to reduce interview costs, was accomplished in two ways. In large city PSU's, where there were large numbers of nonresponse cases, the households were grouped by segment, the segments were sequenced in descending order by the number of followup cases they contained, and a systematic sample of half of the segments was drawn. For the remaining PSU's, nonresponse households that appeared to be convertible were grouped by PSU, the PSU's were sequenced in descending order by the number of these cases they contained, and a 50-percent sample of PSU's was selected systematically. Approximately 4.5 percent of the respondents who were included in the final sample came in as a result of this followup effort. They represent about 9 percent of the population of respondents (because they were subsampled at the rate of 1 in 2) and thus are weighted double relative to other women in the sample.

Characteristics of the sample

Response rates

When calculating screener, interview, and combined response rates, the nonresponse subsampling procedure must be taken into account. For example, to ignore the subsampling procedure entirely would mean that the DU's held for subsampling but not selected, would enter the denominators of the rates even though they did not receive the complete effort to convert them to response DU's (which enter the numerators of the rates). Thus, the procedure would negatively bias the rates. On the other hand, to simply delete the nonselected cases from the calculations would positively bias the rates. That is, if the unselected DU's had been subjected to the same followup efforts as the selected DU's, and if both groups were included in the calculation of response rates, the rates would probably be lower than if the unselected DU's were simply excluded from the calculations.

To overcome these problems the response rates presented in this report are weighted response rates. That is, they are based on numbers of DU's in which subsampled DU's are weighted double relative to others. This weighting allows the subsampled DU's to represent not only themselves but also the DU's held for subsampling but not selected. Thus, the weighted rates are those that *would have occurred if there had been no nonresponse subsampling and if the DU's held for subsampling but not selected had been converted to response DU's at the same rate as subsampled DU's.*

The final combined response rate for the survey was 79.4 percent, the result of a screener response rate of 95.1 percent and an extended interview response rate of 83.5 percent (table C). The screener response rate is the percent of occupied dwelling units for which a screener was completed. The extended interview response rate is the percent of selected eligible women with whom an extended interview was completed; and the combined response rate is the product of the screener and extended interview response rates.

Table C. Weighted screener, interview, and combined response rates, by stratum

Stratum	Screener response rate	Interview response rate	Combined response rate
All strata	95.1	83.5	79.4
Stratum 1	93.6	82.3	77.0
Stratum 2	95.6	84.5	80.8
Stratum 3	94.1	84.2	79.2
Stratum 4	96.2	82.1	79.0
Dormitory	90.7	98.4	89.2

NOTE: The results in this table are weighted for the subsampling of nonresponse cases.

Response rates were highest among ever-married women aged 15–19, lowest among never-married women aged 15–19, and intermediate among women aged 20–44. (See table D.) One reason for the lower response rate among never-married women aged 15–19 was that consent for the interview had to be obtained from both the respondent and from her parent or guardian, when the respondent was a never-married woman 15–17 years of age. This requirement resulted in a higher than average refusal rate for this group.

Table D. Weighted number of eligible women selected for extended interview, weighted number of responding women, and weighted reponse and refusal rates, by marital status and age

Weighted number of women and response and refusal rate	Total	Never married		Ever married	
		15–19 years of age	20–44 years of age	15–19 years of age	20–44 years of age
Number of eligible women selected for extended interview	9,964	2,248	1,796	212	5,708
Number of responding women	8,321	1,813	1,482	182	4,844
Extended interviews:					
Response rate	0.835	0.806	0.825	0.858	0.849
Refusal rate	0.083	0.064	0.075	0.047	0.094
Waiver refusal rate	0.015	0.066	...	...	...
Not at home	0.028	0.029	0.046	0.009	0.022
Other nonresponse rate	0.040	0.035	0.053	0.085	0.035
Screener response rate	0.951	0.951	0.951	0.951	0.951
Overall response rate	0.794	0.766	0.785	0.816	0.807

NOTE: Numbers of women and response rates are weighted for the subsampling of nonresponse cases.

Sample size

The Cycle III (1982) sample design differed from that of Cycle II (1976) in at least five important ways:

- The universe of the survey was expanded to include women 15–44 years of age regardless of their marital status—specifically, never married, childless women were included in Cycle III, but not in Cycle II.
- Teenage women (aged 15–19) were sampled at a higher rate than women 20–44 years of age.
- Intended, or target, sample sizes were established for six groups in Cycle III: (1) black women 15–19 years, (2) black ever-married women 20–44, (3) black never-married women 20–44, and the same three groups for other than black women (table E). In Cycle II, target sample sizes were established for only two groups: Black women and women of other races.
- A sample of "new (post-census) construction" was not used in Cycle III, because the interval between the census and field work in Cycle III was shorter (2 years compared with 6).
- College dormitories were used as a separate stratum in Cycle III, but not in Cycle II.

The 7,969 completed interviews in Cycle III exceeded the required number (7,605) by 4.8 percent, as shown in table E. The number of interviews with ever-married and never-married women aged 20–44 exceeded the target numbers by 7 and 12 percent, respectively. The number of interviews with women aged 15–19 years fell short of the expected number by 5 percent. Case weights were adjusted accordingly.

Table E. Intended and actual sample sizes (unweighted), and the absolute and percent differences, by race, age, and marital status: 1982 National Survey of Family Growth

Race, age, and marital status[1]	*(1) Intended*	*(2) Actual*	*(2)–(1)=(3) Difference*	*$\frac{(3)}{(1)} \cdot (100) = (4)$ Percent Difference*
All races[2]	7,605	7,969	+364	+ 4.8
15–19 years of age	2,015	1,922	− 93	− 4.6
20–44 years of age:				
Never married	1,265	1,414	+149	+11.8
Ever married	4,325	4,633	+308	+ 7.1
Black	3,115	3,201	+ 86	+ 2.8
15–19 years of age	665	596	− 69	−10.4
20–44 years of age:				
Never married	715	819	+104	+14.5
Ever married	1,735	1,786	+ 51	+ 2.9
White and other races	4,490	4,768	+278	+ 6.2
15–19 years of age	1,350	1,326	− 24	− 1.8
20–44 years of age:				
Never married	550	595	+ 45	+ 8.2
Ever married	2,590	2,847	+257	+ 9.9

[1]Race is interviewer-identified race; age is age at screener; ever married includes reported informal marriages. Minor differences will be found in other National Survey of Family Growth reports.
[2]Results in this table are unweighted.

Estimation

Weighting procedures

Overview

The National Survey of Family Growth (NSFG) is designed to produce unbiased estimates for the entire population of eligible women in the conterminous United States, therefore, the sample data must be inflated to the level of the population from which the sample was drawn. The inflation factor, or weight, for each woman is the product of several adjustments, including one or more for each stage of sampling. Three types of adjustments are involved: Inflation by the reciprocal of the probabilities of selection, nonresponse adjustment, and poststratification adjustment.

Inflation by the reciprocal of the probabilities of selection

The weight for each woman is the product of the reciprocals of the probabilities of selecting (1) the primary sampling unit, (2) the enumeration district, (3) the segment, (4) the household, and (5) the eligible sample person (including nonresponse followup if applicable).

Nonresponse adjustment

Each sample weight is adjusted for nonresponse to the household screener (screener nonresponse) and nonresponse to the detailed NSFG questionnaire (interview nonresponse). These adjustments are necessary because nonresponse may introduce bias into a probability sample; women with certain characteristics may be more likely to be nonrespondents than other women, and hence may be underrepresented in the sample. Nonresponse adjustments help to minimize the impact of this bias. Adjustment for screener nonresponse was achieved by imputing to nonresponding households the characteristics of responding households in the same primary sampling unit and stratum. Adjustment for interview nonresponse was achieved by imputing to nonresponding women the characteristics of responding women in the same age-race-marital status class and primary sampling unit.

Poststratification by age and race

The nonresponse adjusted weight for each respondent is then multiplied by a poststratification adjustment factor that is determined by the woman's age, race, and marital status. The 24 adjustment factors shown in table F make NSFG estimates of women in each age-race-marital status category equal to independent control totals for October 1982, the approximate midpoint of data collection. The control totals were derived by interpolation between population estimates from the March 1982 and March 1983 Current Population Surveys (CPS), conducted by the U.S. Bureau of the Census. Poststratification achieves much of the improvement in precision that would have been attained if the sample had been drawn from a population stratified by age, race, and marital status. The technique has been described in appendix II of a previous report.[1]

Table F. Post-stratification adjustment factors, by race, age, and marital status

Race and age	Marital status	
	Ever married	*Never married*
Black		
15–19 years	1.164	1.037
20–24 years	1.021	1.098
25-29 years	1.172	0.976
30–34 years	1.041	1.243
35–39 years	0.953	1.281
40–44 years	0.898	1.411
White and other races		
15–19 years	1.247	1.132
20–24 years	1.169	1.148
25-29 years	1.197	1.240
30–34 years	1.117	1.432
35–39 years	1.090	1.134
40–44 years	1.000	1.139

Estimating Equation

The Cycle III estimator of an aggregate parameter Y for all women in the NSFG target population is the poststratified estimator

$$Y' = \sum_{\alpha=1}^{24} Y'_\alpha \cdot \frac{X^*_\alpha}{X'_\alpha}$$

where α denotes 1 of 24 classes of women defined by crossing two race groups (black and all others) with 6 age groups (15–19, 20–24, 25–29, 30–34, 35–39, and 40–44) and 2 marital status groups (ever married and never married where married means legal marriage),

Y'_α = the weighted, nonresponse-adjusted estimator of Y for women in class α,

X'_α = the weighted, nonresponse-adjusted estimator of the number of women in class α based on NSFG data, and

X^*_α = an independent estimate of the number of women in class α based on data from the Current Population Survey.

The weighted, nonresponse-adjusted estimator for women in class α is given by

$$Y'_\alpha = A_\alpha \sum_{h=1}^{79} W_{1h} \sum_{g=1}^{5} I_{\alpha h} \sum_{i=1}^{L_{hg}} W_{2hgi}\, W_{3hgi}\, R_{hi} \cdot \sum_{j=1}^{H_{hgi}} W_{4\alpha hgij}\, T_{\alpha hgij}\, \delta_{\alpha hgij}\, Y_{\alpha hgij},$$

where

h denotes sampled PSU,

g denotes stratum (strata 1–4 are defined by percent of population that are black and stratum 5 is the dormitory stratum),

i denotes sampled census enumeration district (ED) or block group (BG) and the single sampled segment or part of segment selected within ED or BG i,

j denotes responding household and woman,

L_{hg} = the number of sample ED's or BG's and, hence, segments in PSU h and stratum g,

H_{hgi} = the number of completed extended interviews from segment i, ED or BG i, stratum g, and PSU h.

A_α, $I_{\alpha h}$ } adjustments for nonresponse (discussed later),

W_{1h} = reciprocal of the probability for selecting PSU h,

W_{2hgi} = reciprocal of the probability of selecting enumeration district (ED) or block group (BG) i within stratum g and PSU h,

W_{3hgi} = the reciprocal of the probability of selecting the i-th sample segment or part of segment from ED or BG i, stratum g, and PSU h. This weight is the product of the initial segment weight and the subsample weight for the area finally selected within the ED or BG,

R_{hi} = the reciprocal of the nonresponse subsampling rate for segment i, ED or BG i, PSU h. This weight is
- 2 if the segment or PSU was in the nonresponse subsample and
- 1 otherwise,

$W_{4\alpha hgij}$ = the reciprocal of the probability for including household j from segment i, ED or BG i, PSH h, and stratum g and this weight is
- 1 if the household was black or was in stratum 4,
- 1.5 if the woman selected in the household was 15–19 years of age, and
- 5 if the woman selected in the household was 20–44 years,

$T_{\alpha hgij}$ = the number of women in household j in segment i, ED or BG i, stratum g, BG i, stratum g, and PSU h who were also in the sampling frame that includes the α age-marital status class (these three sampling frames are "all those 15–19 years of age," "ever-married persons 20–44 years of age," and "never-married persons 20–44 years of age"),

$$\delta_{\alpha hgij} = \begin{cases} 1 & \text{if the sampled women from household } j, \text{ segment } i, \text{ ED or BG } i, \text{ stratum } g, \text{ and PSU } h \text{ belongs to the } \alpha \text{ age-race-marital status class and} \\ 0 & \text{otherwise,} \end{cases}$$

Y_{hgij} = the value of characteristic Y for the sampled woman from household j, segment i, ED or BG i, stratum g, and PSU h.

Adjustments are made for nonresponse in two steps. In the initial step, adjustments are made within each PSU for nonresponse up to 50 percent of the sample by the factor

$$I_{\alpha h} = \begin{cases} n'_{\alpha h} / \dot{n}'_{\alpha h} & \text{if this ratio is less than or equals 2,} \\ 2 & \text{otherwise,} \end{cases}$$

where

$n'_{\alpha h}$ = estimated potential number of sample women (number who would be selected to NSFG if 100 percent of the occupied sample dwelling units were screened for eligible women) in class α who are represented by the women actually selected from PSU h —

$$\sum_g \left[\dot{n}1_{\alpha hg} + 2\, n2_{\alpha hg} + 2\, \ddot{m}_{hg} \left(n_{\alpha hg} / \dot{m}_{hg}\right)\right],$$

$\dot{n}'_{\alpha h}$ = estimated potential number of NSFG respondents (number who would have completed extended in-

terviews if Wave II fieldwork had included 100 percent of the convertible nonrespondents) of class α who are represented by actual respondents from PSU h—

$$\sum_{g} [\dot{n}1_{\alpha hg} + 2\,\dot{n}2_{\alpha hg}],$$

$\dot{n}1_{\alpha hg}$, $\dot{n}2_{\alpha hg}$ = are numbers of women of class α who actually completed extended interviews in fieldwork Waves I and II, respectively, in PSU h and stratum g,

$n2_{\alpha hg}$ = number of women of class α included in Wave II fieldwork from PSU h and stratum g,

$n_{\alpha hg} = \dot{n}1_{\alpha hg} + n2_{\alpha hg}$,

$\ddot{m}_{hg}$ = number of occupied sampled dwelling units from PSU h and stratum g that were included in Wave II fieldwork but were never screened for eligible women, and

$\dot{m}_{hg}$ = number of occupied sample dwelling units in which the screening interview and, hence, the within household selection was completed in PSU h and stratum g.

For nonresponse exceeding 50 percent within individual PSU's, adjustment is made across PSU's by the final nonresponse adjustment factor

$$A_{\alpha} = n'_{\alpha} / \dot{n}'_{\alpha},$$

where

n'_{α} = estimated potential number of women of class α who would have been selected for the NSFG if all occupied sample dwelling units were screened—

$$\sum_{h} \sum_{g} n_{\alpha hg}(m_{hg} / \dot{m}_{hg}),$$

$\dot{n}_{\alpha}$ = initial nonresponse adjusted estimate for potential number of women of class α in NSFG sample who would have completed extended interviews if Wave II fieldwork had included 100 percent of the convertible nonrespondents—

$$\sum_{h} I_{\alpha h}\ \dot{n}'_{\alpha h}\ .$$

Variance Estimation

Background

The balanced half-sample replication technique, which is described in detail in other National Center for Health Statistics reports,[4,5] is used to estimate National Survey of Family Growth (NSFG) variances. An empirical study by Bean[6] gives evidence that the half-sample technique produces highly reliable, essentially unbiased variance estimates.

Half-sample replication is being used for several important practical reasons:

1. The complete algebraic formula for NSFG variances is unknown because of the complexity of the survey design. Although algebraic expressions can be derived for particular subprocedures—such as the individual stages of sampling and the poststratification and nonresponse adjustments—a single, exact variance equation has not been developed, and would be very complex if it were attempted.
2. Programming difficulties are reduced because half-sample variances are computed by taking a simple average of squared deviations of half-sample estimates from the estimate based on the full sample. Instead of having to program an exceedingly difficult variance formula, the programmer adjusts the values of certain factors in the estimation formula to computer estimates from appropriately chosen half samples.
3. As stated by McCarthy: "Variance estimates based upon the replicated estimates will mirror the effects of all aspects of sampling and estimation that are permitted to vary randomly from replicate to replicate." [4]
4. Replicated half-sample variances include some of the variability due to nonsampling (measurement) error, as well as sampling variability.[1]
5. Several empirical investigations indicate that the bias of half-sample variance estimates for certain ratio estimators and correlation statistics is negligible, if detectable at all.[4,5,7,8]

Summary of applicable theory

To compute variances by the half-sample replication technique, the population of interest is classified into L-pseudostrata with exactly 2 pseudo-sample primary sampling units (PSU's) each. Selection of exactly 2 sample PSU's reflects an essential element of the theory. This requirement is often met by collapsing 2 strata having one noncertainty sample PSU each, or for certainty PSU's by creating two artificial, or pseudo, PSU's by random methods from a single PSU as well as by combining PSU's in sampling strata having multiple-sample PSU's. The collapsing of strata produces overstated variance estimates by introducing a between-stratum component of variance that does not exist.[9]

Let the parameter of interest be denoted by Y, for which an estimate Y' has been obtained from the complete sample. If Y' is a linear combination of the sample observations, it can be shown that Y' is an unbiased estimate of Y.

A half-sample replicate is defined as a collection of L-pseudo PSU's obtained by selecting one of the paired sample PSU's from each pseudostratum. If the PSU's within each stratum are designated by the subscript $i = 1$ or 2 and there are K half samples, where K is greater than or equal to L, the pattern may be summarized as in table G. The "+" indicates that a PSU falls into a particular half sample, and the "−" indicates that it does not.

Table G. Example of a half-sample replication pattern

Half-sample replication	Stratum 1 PSU		2 PSU		3 PSU		...	L PSU	
	1	2	1	2	1	2		1	2
1	+	−	−	+	−	+	...	+	−
2	−	+	−	+	+	−	...	−	+
3	−	+	+	−	−	+	...	−	+
.	.	.	.	.	.	.	...	.	.
.	.	.	.	.	.	.	...	.	.
.	.	.	.	.	.	.	...	.	.
K	+	−	+	−	+	−	...	+	−

Analogs of Y' corresponding to each half sample are then computed. For example, for the simplest linear estimator Y', the *kth* half sample, Y'_k is given by

$$Y'_k = 2 \sum_{h=1}^{L} Y'_{hi}$$

where i = either 1 or 2 depending on which PSU of the stratum is in the half-sample k, and Y'_{hi} is, in this example, a total. The estimator Y' is

$$Y' = \sum_{h=1}^{L} (Y_{h1} + Y_{h2})$$

and its variance is estimated by

$$S^2_{Y'} = \frac{1}{K} \sum_{k=1}^{K} (Y'_k - Y')^2$$

Because it is impractical to compute the Y'_k for the entire set of 2^L possible half samples when L is large, a subset of half samples is selected to produce the estimates. A set of side conditions relating to the selection of PSU's for the half samples has been developed by McCarthy,[4,5] based on work by Plackett and Burman[10] and Gurney.[11] These side conditions greatly increase the stability of $S^2_{Y'}$ by eliminating a between-strata component of variance that is otherwise present. The value of $S^2_{Y'}$ obtained from a subset of half samples that is chosen according to the McCarthy criteria is equal to the value that would be obtained using all 2^L half samples. A set of half samples that satisfies the McCarthy criteria is called a "balanced set," and the procedure is referred to as "balanced half-sample replication."

Application to the National Survey of Family Growth

As a first step in applying the balance half-sample replication techique to Cycle III, the National Center for Health Statistics grouped the 79 primary sampling units into 37 "pseudo" strata. Eighteen of the pseudostrata were self-representing; each consisted of the PSU or PSU's associated with a single self-representing SMSA. Within each of these strata 2 pseudo-PSU's were created by: (1) listing the PSU's in numerical order within each stratum (for multi-PSU strata); (2) listing the sample segments in numerical order within each PSU; and (3) systematically dividing the segments into two groups, with the first segment and every second-listed segment thereafter assigned to the first pseudo-PSU, and the remaining segments assigned to the second pseudo-PSU.

The remaining 19 strata included the noncertainty PSU's. Their composition was dictated by the way in which these PSU's were originally selected for inclusion in the sample. As described previously, this selection was accomplished in two stages: First, the PSU's were stratified and 35 PSU's were systematically selected; second, all PSU's (both selected and nonselected) were recombined into 19 superstrata and 1 supplemental PSU was selected from each. This design produced two independently chosen observations for each superstratum (the original selection or selections and the supplemental selection) and made the superstrata ideal pseudostrata. By pairing the original selections from each strata with the supplemental selection, 2 pseudo-PSU's were created for each. There was no need for a "collapsing" of population strata to form pseudostrata; hence, the common problem of extraneous between-stratum variance in the half-sample variance estimates was avoided.

Within each of the 37 pseudostrata, a value of 1 was assigned to one of the pseudo-PSU's, and a value of 2 was assigned to the other. Forty balanced half samples were then created by selecting one of the two alternative values from each strata for each half sample; the values chosen were determined by the elements of an orthogonal 40 x 40 matrix of 1's and 2's adapted from Plackett and Burman.[10]

In order to estimate the variance of an aggregate statistic Y', the analog of Y' was computed for each of the 40 half samples.

The half-sample estimate Y'_K was computed in the manner described in the preceding section on estimation, but with case weights adjusted to compensate for the half-sample procedure. The variance of Y' was then estimated by

$$S^2_{Y'} = \frac{1}{40} \sum_{k=1}^{40} (Y'_k - Y')^2 \cdot Q$$

where Q adjusts for the increase in variance caused by the fact that 14 super-(pseudo)-strata contributed either 2 selected PSU's (3 in one case), or the supplemental PSU to each replicate sample, thus causing a variation of weights in replicates that does not exist in the full sample. For estimates of all women or of white women only, $Q = 0.85$; for estimates of black women, $Q = 0.86$ (see Note on page 21).

Half-sample variances were not computed for all statistics produced by the NSFG, because to do so would have required prohibitive amounts of time and money. In additon, data reports would be cumbersome if a variance estimate were published for each statistic. Thus a set of variance estimates was prepared for each of the four major populations of women crossed with two types of statistics produced by the survey: (1) total number of women, (2) number of ever-married women, (3) number of never-married women, (4) number of women 15–19 years of age, and number of pregnancies and births to each of these populations. Each set included variances for numbers of women or pregnancies in selected population subgroups, which were chosen to represent a wide variety of demographic characteristics and a wide variation in the size of the estimates.

A curve was then fitted to each set of relative standard error (RSE) estimates according to the model

$$\mathrm{RSE}(Y') = \sqrt{\frac{S^2_{Y'}}{(Y')^2}} = \sqrt{A + \frac{B}{Y'}}$$

A and B are parameters whose least squares estimates determine the shape of the curve. The rationale for the model and the iterative method that was used to estimate A and B are explained elsewhere.[12]

For each of the 8 groups of statistics named previously, separate sets of variance estimates were produced for black women, for women of white and other races, and for women of all races combined, so that a total of 24 sets of variance estimates were produced initially. Separate estimates were made for black women and women 15–19 years of age, because these groups were sampled at higher rates than other women. Thus, an estimate of a given number of black women has a smaller relative standard error than an estimate of the same number of women of white and other races. For example, an estimate of 500,000 ever-married black women has a relative standard error of 11 percent while an estimate of 500,000 women of all races combined has a relative standard error of 28 percent. Estimates for race, marital status, or age groups that were very similar were combined. Curves for white women and women of all races were combined, for example. Table H shows the estimates of A and B for the 15 curves that resulted from this procedure, and figures 4 and 5 show example curves.

Table H. Estimates of parameters *A* and *B* for relative standard error curves, by type of statistic, marital status, and race

Type of statistic, marital status, and race	*Parameter A*	*Parameter B*
Women 15–44 years of age by marital status and race		
All races and white:		
All marital statuses	−0.0003935957	21306.413351
Ever married	−0.001097329	39809.167683
Never married	−0.0009351043	17608.883330
Black:		
All marital statuses, ever married, and never married	−0.0009086323	6346.048380
Women 15–19 years of age		
All races and white	−0.001456493	13862.104404
Black	−0.003322363	4727.056926
All pregnancies[1]		
All races and white	−0.000001353283	25567.442370
Black	0.0001091980	7143.225243
Pregnancies[1] to ever-married women		
All races and white	0.003120391	43592.725400
Black	−0.0001123101	15678.710304
Pregnancies[1] to never-married women and to teenagers 15–19 years of age		
All races:		
Never married	0.01388728	8660.961987
Teenagers	0.005951224	7802.208396
White:		
Never married	0.07096595	13265.323113
Teenagers	0.01024844	9664.917048
Black:		
Never married and teenagers	0.004546507	3430.760245

[1]Parameters for pregnancies are also used when computing standard errors for numbers and percents of births and living children.

The relative variances of the aggregate statistics are used to derive the relative variances of percents, which are ratios of two aggregates with the numerator being a subclass of the denominator. The relative standard error (RSE) of a percent estimate

$$P' = \frac{Y'}{Z'} \cdot 100$$

is approximated by the expression

$$\mathrm{RSE}_{(P')} = \sqrt{\mathrm{RSE}^2_{(Y')} - \mathrm{RSE}^2_{(Z')}}$$

$$= \sqrt{A + \frac{B}{Y'} - \left(A + \frac{B}{Z'}\right)}$$

$$= \sqrt{\frac{BZ' - BY'}{Y'Z'}}$$

$$= \sqrt{\frac{BZ' - BY'(P'/Y')}{Y'Z'(P'/Y')}}$$

$$= \sqrt{\frac{B(100 - P')}{P'Z'}}$$

where B is the least squares estimate from the relative error curve for Y' and Z' (table H).[12]

Notice that the relative standard error of P' is a function of the values of both P' and Z'. This relationship is demonstrated in figure 5, which shows separate relative standard error curves for percents based on different numbers of ever-married women of all races combined. Each curve satisfies the equation

$$\mathrm{RSE}(P') = \sqrt{\frac{(39809.167683) \cdot (100 - P')}{P'Z'}}$$

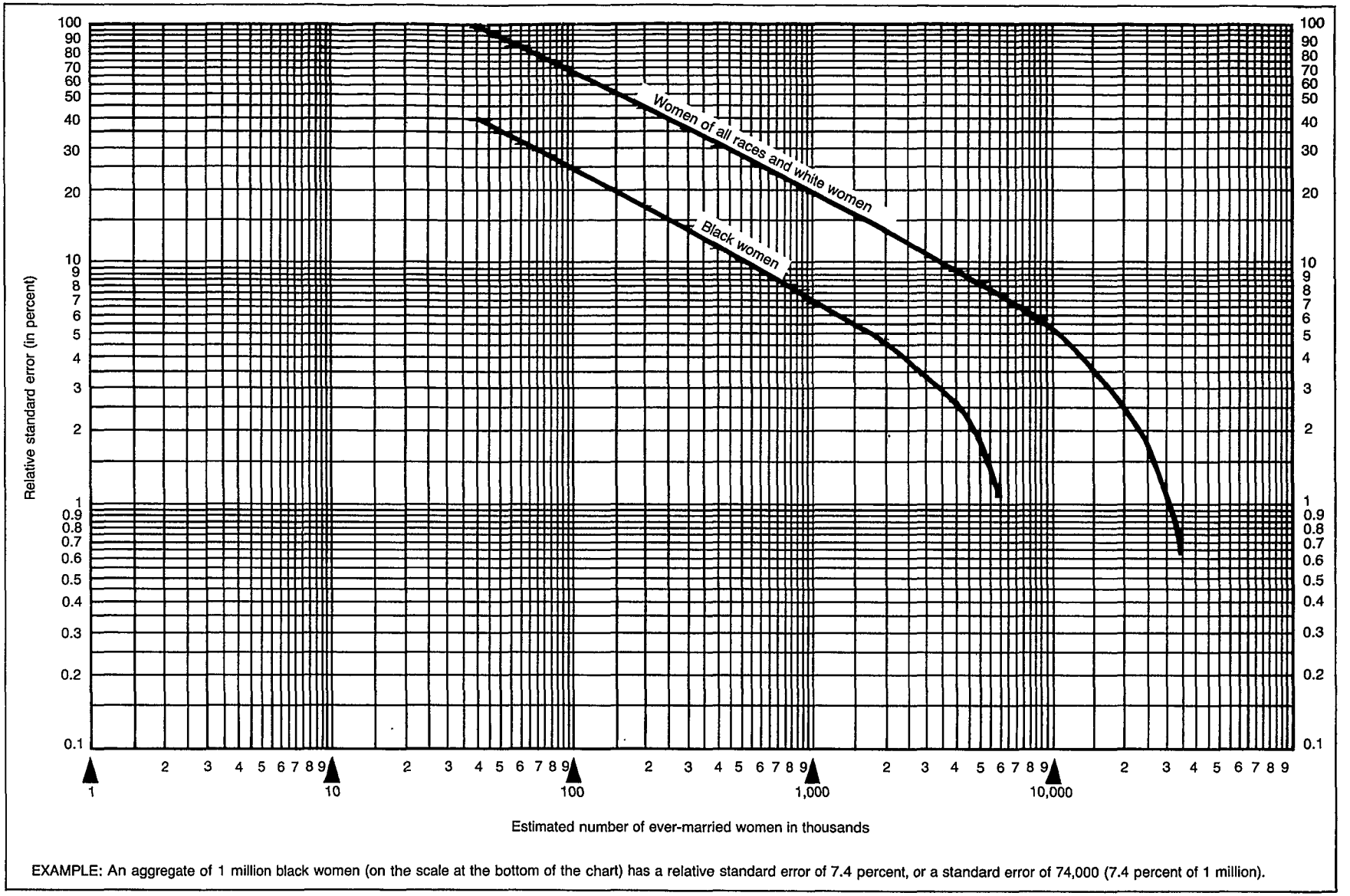
where P' is the estimated percent and Z' is the denominator of P'.

An estimate of the standard error of the difference between any two aggregates or percents is given by

$$S_{(Y'_1 - Y'_2)} = \sqrt{S^2_{Y'_1} + S^2_{Y'_2}}$$

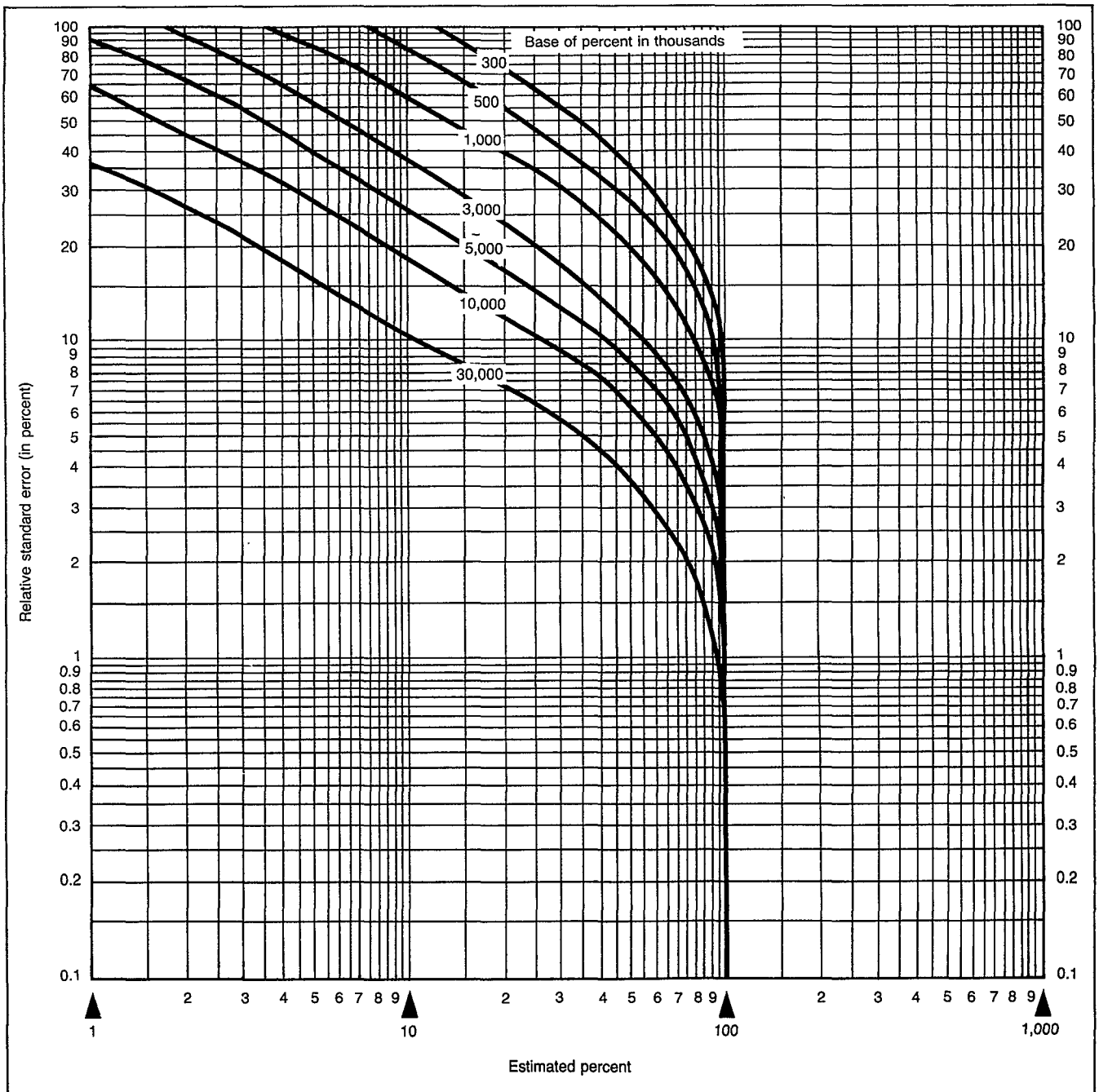
$$= \sqrt{(Y'_1)^2 \cdot \mathrm{RSE}^2(Y'_1) + (Y_2)^2 \cdot \mathrm{RSE}^2(Y'_2)}$$

This expression provides a good estimate of the standard error for uncorrelated statistics, but it can be considered only



EXAMPLE: An aggregate of 1 million black women (on the scale at the bottom of the chart) has a relative standard error of 7.4 percent, or a standard error of 74,000 (7.4 percent of 1 million).

Figure 4. Relative standard errors for aggregates of ever-married women, by race



EXAMPLE: An estimate of 10 percent (from the scale at the bottom of the chart) of a population of 10 million women (second curve from the bottom) has a relative standard error of 18.9 percent, or a standard error of 1.8 percent (18.9 percent of 10 percent).

Figure 5. Relative standard errors for percents of ever-married women of all races

a rough approximation otherwise. Because estimates from Cycle III of the National Survey of Family Growth are based on a large sample of women, the distributions of Y'_1 and Y'_2 (and, therefore, $Y'_1 - Y'_2$) are approximately normal. Frankel[13] shows empirically that, using balanced half-sample replication estimates of variance, the test statistic

$$t = \frac{Y'_1 - Y'_2}{S_{(Y'_1 - Y'_2)}}$$

approximates the student's t distribution under the null hypothesis of no difference between the parameters estimated by Y'_1 and Y'_2 against a two-sided alternative. The number of replicates in the replication design (40 for Cycle III) minus one can be used as the number of degrees of freedom for the t statistic, although the exact value for the degrees of freedom remains unknown. Therefore, individual two-tailed significance tests of differences between statistics from Cycle III data can be performed with an approximate significance level of alpha by computing t and comparing it to the two-tailed 1-α critical value for the t distribution with 39 degrees of freedom.

Example: In 1982, 68.8 percent of 25,195,000 currently married white women were using some method of contraception, compared with 61.0 percent of the 2,130,000 currently married black women. To test this racial difference at the .05 level of significance, compute

$$t = \frac{68.8 - 61.0}{\sqrt{(68.8)^2 \cdot \mathrm{RSE}^2_{(68.8)} + (61.0)^2 \cdot \mathrm{RSE}^2_{(61.0)}}}$$

Relative standard errors are computed using the appropriate values for B from Table H:

$$\mathrm{RSE}_{(68.8)} = \sqrt{\frac{(39809.1677) \cdot (100 - 68.8)}{(68.8) \cdot (25{,}195{,}000)}}$$

$$= 0.027$$

and

$$\mathrm{RSE}_{(61.0)} = \sqrt{\frac{6346.0484 \cdot (100 - 61.0)}{(61.0) \cdot 2{,}130{,}000}}$$

$$= 0.044$$

thus

$$t = \frac{68.8 - 61.0}{\sqrt{(68.8)^2 \cdot (0.027)^2 + (61.0)^2 \cdot (0.044)^2}}$$

$$t = 2.39$$

The two-tailed .95 critical value (1-α) for a t statistic with 39 degrees of freedom is 2.02. Therefore, the difference is significant at the .05 level.

NOTE: As stated on page 6, one PSU was selected twice, so two sets of segments from that PSU were used in the survey. After the variances for the survey were estimated and after several publications of NSFG data, it was discovered that the two sets of sample segments from that PSU had been mistakenly combined. The sample segments in that PSU that represented the first and second time it had been selected should have been treated as two separate PSU's during the estimation and variance computations. When this error was discovered, the segments in that PSU were divided between the first and second times the PSU was selected, and estimates and variances were recomputed. Differences between the original and revised variance estimates were extremely small (less than 0.5 percent of the estimated parameters) and had no effect on any analytic results. Therefore, the original variances were retained and are shown in this report.

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